THE LITERARY MAGAZINE.

OCTOBER 1736.

ARTICLE LV.

Eſſais Politiques ſur le Commerce, par Monſieur **** *a* Amſterdam. *Chez* FRANCOIS CHANGUION, 1735, *in* Octavo, *p.* 250; *et le ſevend a la* Haye, *chez* Jean Van Duren. *Or, A Politic Eſſay upon Commerce, by Monſieur* **** *at* Amſterdam. *By* FRANCIS CHANGUION, 1735, *in* Octavo, *containing* 250 *pages*; *and is ſold at the* Hague, *by* John Van Duren.

ONE can't put too great a value upon thoſe, who employ their thoughts and leiſure on profitable reſearches. Commerce is the principal fountain of the ſecurity and the happineſs of a people. To ſecure it, to extend it, and to render it eaſy, ought to be the great object of all thoſe who govern the ſtate, and of every particular perſon, who can contribute any thing to theſe wholſome ends. The author of this eſſay uſes no violence to this affair; then he ſays, that thence the moſt elevated, the moſt grand, of reaſon and acquir'd lights, is to employ theſe things and apply them to a general policy, from whence depends the public happineſs; that the meditations, the conferences, the writings upon theſe important matters, give us new ideas, and often preſent us objects, with faces till then quite unknown; that the ſame things often repeated, by different perſons, acquire more force, and may determine a legiſlator, whoſe good intentions are not always ſupported by courage enough, to oppoſe the torrent of prejudices.

Altho' this little work contains only general principles, that the conciſe manner and almoſt enigmatical, in which it is writ, places it beyond the reach of the better part of readers: however, I believe I ſhall do the readers ſome

pleaſure to give them a ſhort idea of it. His intention is to make us think, that *France* is ill govern'd in regard to commerce, that ſhe does not make a right uſe of her advantage; and at the ſame time to point out the falſe ideas, which hinder her from remedying theſe diſorders.

He ſuppoſes three or four iſles upon the earth, each iſle of the ſame extent, and equal number of the inhabitants, and has produc'd nothing but the ſame kind of goods, of which that ground is the moſt proper, one of corn, and the other of wool, *&c.* The ſame number of people is employ'd in labour, and the produce is ſufficient to furniſh the three other iſles.

There immediately commences a neceſſary commerce, in ſuch ſort, that each iſle in reſerving to itſelf a ſufficient quantity of its own produce, will exchange the reſt to have its proviſion from other iſles: the neceſſity and the exchanges are equal, and of courſe the ballance of trade will be equal. But if one of the iſlands ſhould become cultivated enough to have its proviſion of that which is in the others, and moreover a ſuperabundance of its own growth which the others want; what would happen in policy and in commerce?

Suppoſe it were the iſle which produces corn, as the others can't bear it, the firſt thing which every inhabitant will do, will be to abandon his own iſle and go and labour in this iſle of corn to get his living.

Upon this ſuppoſition, that one of the other iſles ſhould have a ſuperfluity of its proper produce, and ſufficient of that that were in the others, its advantage would not be ſo great as that of the iſle of corn; becauſe the other produces are not abſolutely neceſſary for life, and the iſles intereſted would have time to take meaſures to ſubdue it, or to conſtrain it to an equality of commerce; but in the ſcarcity of corn, if the remedy is not ready all is undone. An army, where bread is wanting, knows no diſcipline.

Thus corn is the baſis of commerce, becauſe it is the ſupport of life, and its proviſion ought to be the firſt object of the legiſlature.

When one of the iſles makes a great progreſs in agriculture or in manufactures this muſt happen, becauſe the number of the inhabitants is augmented; or, which amounts to the ſame thing, becauſe it has the induſtry to cultivate the ſame number of acres to make the ſame quantity of works with fewer hands. Now theſe ſuperfluous men may equally ſerve to multiply their own produce, or to become conquerors of the other iſland. From whence it follows, that increaſe of inhabitants ought to be the ſecond object of the legiſlature; and it is a manner of increaſing inhabitants, by making men labour at leſs expence.

By the combination of all their different commerces, one iſle with a much greater number of inhabitants than another may become inſenſibly leſs abundant, leſs peopled, or in ſhort, may be ſubdued; for the number of inhabitants, the extent and fruitfulneſs of the ground are uſeleſs in places where

where the earth remains untill'd by idleneſs or diſcouragement.

From all this, the author gives us the definition of trade, which is nothing elſe he ſays but an *exchange* of ſuperfluities for *neceſſaries*. He adds, that the progreſs of power of any iſle may eaſily be known, in examining, *1ſt*, If the earth produces more corn, or ſome other equivalent produce. *2dly*, If its policy and induſtry augment the number of its inhabitants. *3dly*, If the quantity of the equivalent of exchanges be in ſuch proportion as affords to each proprietor the means of advantaging himſelf of what he poſſeſſes, ſo as to acquire what he wants.

With theſe advantages, one iſle may deſtroy the ballance of equality, and may arrive at a ſuperiority, and may give laws to the other iſlands. But then ſhe muſt conduct herſelf by new politic intereſts; for not being arriv'd at this high degree but in finding within itſelf all the ſupports which the others have not, theſe being impoveriſh'd, will have nothing to give in exchange of their neceſſities; and commerce, which by its eſſence is reciprocal, will be deſtroy'd. What is the advantage then of this predominant iſle? It is this, that it will draw by its induſtry the inhabitants of the impoveriſh'd iſles to it, who will abandon their native country to become hirelings in a country of abundance, and this increaſe of inhabitants confirms its power. Moreover, the rich iſle will ſuſtain commerce in the iſles, from whence they have nothing to fear, and will ruin that of the iſles where the concurrence may alarm it; and thus its tranquility will equal its power.

To theſe general principles, which repreſent the ſtate of *France*, he joins this detail. The greateſt abundance of corn, ſays he, is generally follow'd by a ſcarcity, perhaps becauſe the leſſening the price diſcourages the labourer. Then they form vaſt projects to build magazines, to ſecure the people for ever from famine. But theſe projects, which actual miſery had brought into the world, vaniſhed in proportion as the remembrance of the evil was far removed from them; and being ſo much fill'd with the preſent abundance, they can hardly buſy themſelves with the thoughts of what is to come, which appears ſo uncertain. In a little ſtate, where there is a ſmall growth, and where corn comes always from ſtrangers, theſe magazines may be of very great uſe. Their regulation, wiſely conducted, will eaſily occaſion the price to be no charge to the people. But in a great ſtate, where a great produce, nay more than ſufficient, is the caſe, then theſe magazines are of dangerous inconvenience. They can't be built nor ſupported but at great expences. The bad corn will be equally exported with the good, and will be corrupted in the keeping. The undertakers will not ſuffer any loſs, and the difficulty, which the legiſlator finds himſelf under to avoid their ſnares of ſelling it by preference, embarraſſes him. From whence, we ſhould

have bad bread, and epidemic diſtempers.

France contains within itſelf the products of the firſt ſuppoſition of the iſles. She more eſpecially has plenty of corn; but as all the provinces don't abound alike in one and the ſame year, the legiſlator may prevent the conſequences by taking an exact account of the inhabitants in each province, and of the quantity harveſted. Thus he may ſuffer the province which produces the leaſt, to draw the ſuperfluous grain from other provinces that abounded, and thus he will hinder the too great dearneſs ruinous to the one, and the lowneſs of price which increaſes the labourers in the other.

Thus the firſt object of the legiſlator, the aſſurance of bread, is a matter of great eaſe in *France*, as it would be in the iſle of corn. It is much more difficult, and not leſs important, to hinder the lowneſs of price by the too great abundance. Then the particular permiſſions to ſend to ſtrangers, don't agree ſo well with ſubalterns, unleſs at the expence of money, and with ſuch formalities as make the proprietor of the grain loſe all his profit.

Why ſhould a general order at all be agreed too irrevocably, when the height of the price ſhall become chargeable to the people?

This method is not at all to be contemned.

The more we enter into this little work, the more ſenſible are his reflections. The greateſt of maxims, ſays he, and the moſt known, (he might have added, and the leaſt practiſed in *France*) is, that the commerce demands liberty and protection. And if liberty has any reſtriction, as to corn, it ought alſo to be laid upon all other merchandiſe whatever. Their ſcarcity or their abundance, their dearneſs or their moderate price, muſt be but momentary, and of little conſequence; a variation not prejudicial to the citizen, and advantageous to the merchant, whom it incites to take pains.

In the alternative betwen liberty and protection, it would be leſs hurtful to take away protection than liberty; for with liberty the force of trade only ſtands, inſtead of protection.

It is a manner of taking away liberty to moderate the rights of any merchandiſe in favour of any particular, under what pretence ſoever it be. It is to authoriſe a monopoly, which becomes more dangerous as being under ſhelter of the law. Then the merchant remains idle, he who by correſpondence, ſolidly eſtabliſh'd, would have made a good market of his produce, whereas the greedy, privileg'd perſon, will ſell much dearer, and yet be indemnified.

The equivalent of this advantage is ſometimes given to ſtrangers, by impoſition of new formalities, which make them ſell their goods at a cheaper rate. In the laſt war a tax was laid upon cards, which annually amounted to fifty thouſand livres; this childiſh and ridiculous object made *France* loſe the general commerce of cards. Altho' the tax is taken off, yet the trade has never return'd, becauſe when once a trade is loſt it

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is hard to recover it. Particularly where there are neighbours attentive to take advantage of faults of this kind.

He ſpeaks thus of the augmentation of the inhabitants; he pretends it appears very true, that the celibacy of prieſts and a monaſtic ſtate are very hurtful to a ſtate: He aſks, by what religious or politic principle it is forbid to chriſtian *Europeans* to have ſlaves, ſince we ſee them daily tranſported at ſuch expence into *America*? To favour marriages, continues he, to agree to aſſiſt a father charged with a numerous family, to watch over the education of orphans and foundlings, will fortify a ſtate much more than to make conqueſts: The taking of a town, what with the loſs of the men, and the expence of money, abates the value of the conqueſt. To grub up the earth, is to make a conqueſt without being miſerable. The territories from *Bourdeaux* to *Bayonne*, contain twenty leagues in diameter. The legiſlator who would people theſe, does a greater ſervice to the ſtate than he, who by a murthering war ſhould conquer the ſame quantity of ground. But it would not appear ſo bright in the eyes of the vulgar, becauſe it was not got by military danger, without loſing one citizen, and without drawing upon him the jealouſy of his neighbours.

The idea which this writer gives of the *Muſcovites*, deſerves a ſingular attention. The *Muſcovite* nation, ſays he, was in a manner unknown in *Europe*, till the czar *Peter* endeavour'd to make it a merchantile nation. Its force keeps pace with its progreſs of policy and commerce, and not at all according to its territories, which are vaſtly immenſe. Her new marine and port of *Peterſbourg*, built almoſt in the ſpight of nature, are much more uſeful to her, than the vaſt countries of *Siberia* and *Tartary*. The force of a ſtate bears no proportion with the ground, but the number of citizens, and the produce of their labours.

Permit me, ſays he, to make ſome reflections on this new power, which has aroſe on a ſudden. One muſt obſerve the ſpirit of the legiſlature, with which the czar *Peter* was animated, dwindled after his death, or at leaſt after ſo many changes of ſoveraigns and miniſters. Mean while they proceed upon the ſame principle, the ſame ſpirit conducts them, and the miniſter who ſucceeds leſs jealous of the eſtabliſhments of its predeceſſors, than of the glory to perfect them, ſticks to facts.

A body of troops fill'd with engineers and workmen neceſſary, is gone to the ſea of *Japan* to eſtabliſh ports there, which by the means of canals and rivers, will communicate with the gulph of *Lena*, to the *Caſpian* ſea, and *Peterſbourg*. Works immenſe, labours aſtoniſhing, which will reunite the moſt diſtant parts of *Aſia* and *Europe*!

In ſhort, the ſpirit of peace has clear'd up our *Europe*, and it will ever be a juſt ballance, from hindring one power to lord it over another; and if any momentary intereſt trouble this happy harmony, the

the conqueror cannot hope to extend his limits; every one ought to unite to put a ſtop to ſuch dangerous progreſs, and a nation cannot aggrandize itſelf more, than by the wiſdom of its government.

'Tis the misfortune of moſt framers of ſyſtems to add ſomething joco-ſerious; this is the caſe of our author; he brings-in a long diſſertation to prove it would be much to the purpoſe, to re-eſtabliſh the uſe of ſlaves, which chriſtianity has aboliſhed. But who will come into his meaſures? the ſoveraigns themſelves will not bear to re eſtabliſh them.

Obſerve another treatiſe no leſs remarkable; after having ſaid a great number of good things for induſtry, and againſt idleneſs, he adds this reflection, which we cannot ſpeak without burleſque. Nature has implanted in the two ſexes, a mutual deſire to be together, to pleaſe and gratify one another. That which gallantry and a polite education cauſes gentlemen of the world to do for ladies, the peaſant will do the ſame in a groſs manner for the country girl; if the gentlemen are proud to ſhew themſelves in armour, the peaſant is alſo proud to ſhew how well he can handle the baſket. When the men and the women labour together, in digging a large canal, or making a great road, labour becomes more ſpirited, and leſs difficult. The object which the legiſlator ſhould never loſe view of, is to render men as happy as their miſerable condition will permit, and from this principle there ſeems to be no more ſcandal than to ſee men and women together in public walks, or at churches; take away one ſex, the other will have no inclination to go thither. We have all of us the ſeeds of the ſame paſſions within us, 'tis education only that varies the effects.

The reſt of the work is full of curious obſervations upon the change of money, upon letters of exchange, upon public credit, upon banks and upon companies of commerce. It were highly to be wiſh'd, that thoſe who are at the head of affairs would make a proper advantage of the treatiſe, to give to commerce all the liberty it can have, and to eſtabliſh a manner more eaſy and leſs arbitrary, to draw from the people the ſuccours which they have occaſion for.

ARTICLE

ARTICLE LVI.

An Abridgment of Algebra *and* Fluxions.

Gentlemen,

" As theſe two ſciences have been improved much of late, " and are of ſuch extenſive uſe, I thought it would be of " great ſervice to youth to give a brief inſtitution of them, " by lopping off all the uſeleſs *rationale* on them, in order " to ſhorten the labour beſtow'd on them in the common " way; as you were ſo complaiſant as to do juſtice to the " *Art of Thinking*, you may alſo think it worth while to do " the ſame by this; the work is ſhort and fitteſt for your " purpoſe, and you are welcome to it.

ALGEBRA

IS a ſpecious arithmetic, or an arithmetic in letters; it conſiſts of addition, ſubſtraction, multiplication and involution, and diviſion and evolution, beſides of the art of equation and the rules of proportion, *&c.*

There are certain ſigns made uſe of in *Algebra*,

&c. +	*ſignifies*	addition, and is term'd *plus* or more.	*co-efficients*, are the numbers *v. g.* 4, 5, 6, *&c.* *Like quantities*, *a* and *a*; *unlike*, *a* and *b*.
—		ſubſtraction, and is called *minus* or leſs.	
×		multiplication.	
÷		diviſion, or $\frac{a}{a}\frac{b}{}$	
@		involution.	
w		evolution.	
::		like proportion	
∴		continued proportion.	
=		equality or equal to.	

N. B. Whenever there is no ſign prefix'd, the ſign + is underſtood.

Addition.

Rule 1. *If quantities are alike, and the ſigns are alſo alike, ſet down the ſigns, add the co-efficients*, v. g.

a	$-a$	$5b$	$-7b$	$3a+5b$	$3a-5b$	$6ab+12$
a	$-a$	$3b$	$-8b$	$2a+7b$	$2a-7b$	$3ab+24$
$a+a$	$-a-a$	$5b+3b$	$-7b-8b$	$5a+2b$	$5a-12b$	$9ab+36$
or	or	or	or			
$2a$	$-2a$	$8b$	$-15b$			

Rule

Rule 2. *If the quantities are alike, but the ſigns unlike; ſubſtract the co-efficients, and ſet down the ſign of the greater,* v. g.

$+5a$	$-5a$	$7bc$	$-9abd$	$7a-5b$	$-8ab-7bc+15$
$-3a$	$+3a$	$-6bc$	$+7abd$	$5a+7b$	$12ab+7bc-24$
$+2a$	$-2a$	$1bc$	$-2abd$	$12a+2b$	$+4ab+0 \quad -9$

Rule 3. *If the quantities are unlike, ſet down all.*

a	a	$5b+7dc$
b	$-b$	$4a-20$
$a+b$	$a-b$	$5b+7dc+4a-20$

N. B. If quantities be like and ſigns unlike, if they be equal, the ſum is equal to nothing, *v. g.*

$6a$	$8b+6c-8c+3d$	
$-6a$	$8b-6c+8c-3d$	
0	$0 \quad 0 \quad 0 \quad 0 \quad 0$	

Examples of all the rules conjoin'd.

$3aa+4abc-bb+30$
$2bb-3aa-2abc-25$
$dd+2aa-3abc-3$

Place likes under their likes, for here they are diſplac'd, then add them together, *v. g.*

$3aa-bb+3abc+30+dd$
$-3aa+2bb-2abc-25$
$+2aa-3abc-3$

$+2aa+bb-2abc+3+dd$

SUBSTRACTION.

The Rule. *Change all the ſigns of the ſubtrahends, or imagine them to be changed, then proceed as in addition,* v. g.

$2a$	$-2a$	$8bc$	$-15bc$	$5a$	$+12b$
a	$-a$	$3bc$	$-3bc$	$2a$	$+7b$
a	$-a$	$5bc$	$-12bc$	$3a$	$+5b$

ſubtrahends.

$9ab+36$	$+2a$	$-2a$	$5ab-12b$		
$3ab+24$	$+3a$	$+3a$	$2ab-7b$		
$6ab+12$	a	$-a$	$3ab-5b$		

ſubtrahends.

$9ab$

$9ab+36$	$4ab-21$	
$3ab+24$	$-8ab-7bc+15$	*subtrahends.*
$6ab+12$	$4ab-7bc-6$	

Multiplication.

Rule 1. *Where quantities are join'd with like signs, without co-efficients, prefix a positive sign, and join the like quantities,* v. g.

a	$-a$	$a+b$	$a+b$
b	$-b$	d	$a+b$
$+ab$	$+abda+db$		$aa+ab$
			ab
			$+bb$
			$aa+2ab+bb$

Rule 2. *If there be co-efficients, multiply them together, and to their products join the quantities,* v. g.

$5a$	$-6d$	$3a+2b$	$a+b$
$3b$	$-7b$	6	$5b$
$15ab$	$+42db$	$18a+12b$	$5ab+5bb$

Rule 3. *If there be quantities, but the signs are unlike, join the quantities with the sign* —; v. g.

$+a$	$-6d$	$4a-7b$	$4a-7b$
$-b$	$+7b$	$3f$	$-3f$
$-ab$	$-42db$	$+12af-21fb$	$-12af+21fb$

Division.

Rule 1. *If there be quantities with like signs, but no co-efficients; expunge the like quantities in the dividend, that are in the divisor, and put the sign + before them,* v. g.

ab	$-ab$	$ad+bd$	$ad-db$
b	$-b$	d	$-d$
a	a	$a+b$	$a+b$

Rule 2. *If quantities have co-efficients, then do as in common diviſion, ſc. divide the co-efficients, and expunge,* v. g.

$15\,ab$	$42\,db$	$12\,af - 21\,bf$
$3\,a$	$-7\,b$	$3f$
$5\,b$	$-bd$	$+4\,a - 7\,b$

Rule 3. *If the diviſor and dividend be the ſame, the quotient is* 1, v. g.

ab	$9\,bc$	$7\,ab + 5\,bc$
ab	$-9\,bc$	$7\,ab + 5\,bc$
$1\,ab$	$-1\,bc$	$1\,ab + 1\,bc$

Rule 4. *If quantities in the dividend be with unlike ſigns in the diviſor, ſet down the quantities with the ſign* —, v. g.

ab	$-ab - bd$	$abc + bcd + bcf$
$-ab$	$+b$	$-bc$
$-b$	$-a - d$	$-a - d - f$

Rule 5. *If the quantities are not to be found, ſet them down fraction-wiſe,* v. g.

$\frac{bbc}{3d}$	$\frac{a}{b}$	$\frac{5b+4a}{5d+7b}$
$\frac{bbc}{3d}$	$\frac{a}{b}$	$1\,\frac{b}{d}\,\frac{4a}{7b}$

INVOLUTION, *or* POWERS,

Is a multiplication of like quantities.

a	aa	aaa	$aaaa$
a	a	a	a
aa	aaa	$aaaa$	$aaaaa$
or	or	or	or
a^2	a^3	a^4	a^5

N. B. $a \times a = aa$ or a^2 is a ſquare

$a \times a \times a = aaa$ or a^3 is a cube

$a \times a \times a \times a = aaaa$ or a^4 is a biquadrate

$a \times a \times a \times a \times a = aaaaa$ or a^5 is a ſurſolid

$a + b$

$a+b$	$aa+2ab+bb$
$a+b$	$a+b$ &c.
$aa+ab$	$a^3+2a^2b+ab^2$
$ab+bb$	$ba^2+2ab^2+b^3$
$aa+2ab+bb$	$a^3+3a^2b^2+3a^2b^2+b^3$
$a-b$	$aa-2ba+bb$
$a-b$	$a-b$
$aa-ba$	$a^3-2a^2b+ab^2$ &c.
$-ba+bb$	$-a^2b+2ab^2+b^3$
$aa-2ba+bb$	$a^3-3a^2b+3ab^2-b^3$

$a+b$ is called a *binomial* root.

$a-b$ is called a *reſidual* root.

One may involve thus to any power whatever, by continual multiplication of any by the ſame root.

The great Sir *Iſaac Newton* found out an expeditious way to prefix the numbers, which he calls *unciæ*, to any power. For example,

Suppoſe then $a+b$ were to be involved to the 7th power.

1. The powers from a *binomial* are + before every term; but from a *reſidual*, they are interchangeably + and —, as you ſee by the involution of $a+b$ and $a-b$.

2. The leading quantity decreaſes in arithmetical proportion, the others increaſe in the ſame proportion, *v. g.*

$$a^7+a^6+a^5+a^4+a^3+a^2+a$$
$$b+b^2+b^3+b^4+b^5+b^6+b^7$$

Now join theſe thus, it will be without the *unciæ*,

$$a^7+a^6b+a^5b^2+a^4b^3+a^3b^4+a^2b^5+ab^7.$$

3. Two *index's* join'd are always equal to the power, *v. g.*

a^6 and once $b=7$, a^5 and $b^2=7$ &c.

4. To find the *unciæ*, Sir *Iſaac* has this method,

$$1\times\frac{m-0}{1}\times\frac{m-1}{2}\times\frac{m-2}{3}\times\frac{m-3}{4}\times\frac{m-4}{5}\times\frac{m-5}{6}\times\frac{m-6}{7}\ \&c.$$

To explain this theorem, m is the exponent of the power; now m is 7 in the 7th power, 6 in the 6th, &c. ſo that he

means 1×-0 and $\div 1=7$ the 1ſt *unciæ*; then $7\times7-1=6=7\times6=42$ and $42\div2=21$ *the ſecond unciæ*; then $21\times7-2=5=105$ and $105\div35$, *the third unciæ*; then $35\times7-3=4$, $\div140$, and $140\div4=35=$ *the fourth unciæ*; then $35\times7-4=3=105$ and $105\div5=21=$ *the fifth unciæ*; then this *unciæ* $21\times7-5=2=42$, and this $42\div6=7=$ *the ſixth unciæ*; then theſe *unciæ* $7\times7-6=1=7\div7=$ one; ſo then the *unciæ* and *powers* united ſtand thus,

$$a^7+7a^6b+21a^5b^2+35a^4b^3+35a^3b^4+21a^2b^5+7ab^6+b^7$$

EVOLUTION.

As involution is a multiplication, ſo evolution is a ſpecies of diviſion.

If the power given have no numbers (or *co-efficients*) prefix'd to it, and its *index* can be divided by the *index* of the root required, the quotient will be the *index* of the root ſought, *v. g.* Let the $\sqrt[3]{}$ (or cube root) of a^6 be required, then

$\div\ {}^{a^6}_{3}\left(=a^2.\right|$ or $3\Big)\,a^6\,\left(a^2=\right.$ root ſought.

	1	a^6	$a^6\ b^6$	$a^6\ b^6\ d^6$
1 *ww* 2	2	a^3	$a^3\ b^3$	$a^3\ b^3\ d^3$
1 *ww* 3	3	a^2	$a^2\ b^2$	$a^2\ b^2\ d^2$
1 *ww* 4	4	a	$a\ b$	$b\ b\ d$

N. B. The figures (1 *ww* 2; 1 *ww* 3; 1 *ww* 4) denote the *index* of the root to be extracted.

If the given powers have co-efficients; then you muſt contract their reſpective roots as in arithmetic, *v. g.*

	1	$81\ a^4$	216	$a^8\ b^8$
1 *ww* 2	2	$9\ a^2$	36	$a^4\ b^4$
1 *ww* 3	3	$3\ a$	6	$a^2\ b^2$

But if the root required cannot be truly extracted out of both the co-efficients and *indices* of the given power, then it is a *ſurd*, and muſt have the ſign of the root requir'd prefix'd to it, *v. g.*

	1	a^5	$67\ a^4$	$21\ bb3\ d3$
1 *ww* 2	2	$\surd\ a^5$ or $\surd^2\ a^5$	$\surd$ or $\surd^2\ 67\ a^4$	$\surd$ or $\surd^2\ 21\ bb^3\ d3$
1 *ww* 3	3	$\surd^3\ a^5$	$\surd^3\ 67\ a^4$	$\surd^3\ 67\ b3\ d3$

To discover readily the roots of all compound powers in general; observe, that if either the sum or difference of several quantities be involved to any power, there will arise so many single powers as there are different Quantities, *v. g.*

$a+b+d$ squar'd, 'tis $aa+2\,ba+a\,d+bb+2\,bd+dd$, here is *aa*, *bb*, *dd*.

When you have extracted the root, involve it again to try whether it amounts to the same; if not, it is either badly evolv'd, or 'tis a surd, of which more hereafter.

Of FRACTIONS.

To prepare Fractions.

Sect. 1. $\frac{a}{b}$, $\frac{2\,bc}{d}$, $\frac{5\,b-4\,a}{4\,d+7\,b}$ } numerators / denominators } are fractions.

Sect. 2. To change fractions into one denomination, multiply the denominators into the numerators, and subscribe the denominators, *v. g.*

$\frac{a}{b}\ \frac{1}{2}\ \frac{d}{c}$; $a \times c = a\,c$, and $b \times d = b\,d$; subscribe $b\,c$; then 'tis $\frac{a\,c+b\,d}{b\,c}$.

Sect. 3. To bring integers into fractions, multiply integers into the denominator for a numerator, and then write the denominator under, *v. g.*

$a+b$ to be brought into a fraction, whose denominator is $d-a$.

$\times \frac{a+b}{d-a}$ } $=d\,a+d\,b-a\,a-b\,a$ } then 'tis $d\,a+d\,b-aa-b\,a$ } then 'tis $\frac{d\,a+d\,b-aa-b\,a}{d-a}$

Sect. 4.

Sect. 4. To abbreviate fractions; divide the numerator by the denominator, *v. g.*

$$\frac{aa\,c}{d\,c} \text{ then 'tis } \frac{aa}{d}$$

N. B. When fractions are thus prepar'd, they are fit for addition and other operations.

ADDITION, SUBSTRACTION.

In addition and subſtraction, add or subſtract the numerators (*ſc.* their ſums or differences) and ſubſcribe their common denominator, *v. g.*

Addition.

$$\frac{bb}{c} \quad \frac{aa}{c} \quad \frac{a+b}{d} \quad \frac{2a+c}{d}$$

$$\frac{bb+aa}{c} = \frac{3a+b+c}{d}$$

Subſtraction.

$$\frac{3a+b+c-2a+c}{a \qquad d} \quad \frac{a+b}{d+c} \quad \frac{2b-a}{d+c}$$

$$= \frac{a+b}{d} \qquad = \frac{2a+b}{d+c}$$

MULTIPLICATION.

Multiply the numerators together for a new numerator, and the denominators for a new denominator, having thus prepared them as above, *v. g.*

$$\frac{ab}{c} \quad \frac{d}{f} \quad \frac{3a-2b}{2d+c} \times \frac{4a+2b}{d}$$

$$\frac{-abd}{cf} = \frac{12a-2ab-4bb}{2dd+c}$$

N. B. Any fraction is multiplied by its denominator by caſting off the denominator, *v. g.*

$$= \frac{\frac{b}{a}}{b} \left\{ \begin{array}{l} \text{ſc. } \frac{a}{a} \div \\ \end{array} \right. (= 0$$

$$2a + \frac{b}{c} - 25 \times 3b + 4c$$

Prepare as in *Sect.* 3. then

$$\frac{2a + \frac{b}{c} - 25c + 3b + 4c}{1} =$$

$$\frac{6ba\,c + 3b^2 - 75bc + 8ac^3 + bc - 100\,cc}{c}$$

DIVISION.

Division.

Multiply the numerator of the dividend into the denominator of the diviſor for a new numerator, and multiply the other together for a new denominator (*ſc.* 1. abbreviate, then divide) *v. g.*

$$\frac{abd}{cf} \div \frac{ab}{c} = \frac{abdc}{abcf} = \frac{d}{f}$$

Involution.

Involve the numerator into itſelf for a new numerator, and the denominator into itſelf for a new denominator, *v. g.*

$$\frac{a}{b} = \frac{aa}{bb}\ ;\ \frac{aa}{bb} = \&c.$$

Evolution.

Evolve the numerators and denominators, *v. g.*

$\frac{9aabb}{4dd} = \frac{3ab}{2d}$ } *N. B.* If it has no root, prefix the ſign $\sqrt{}$ $\sqrt{3}$ $\sqrt{4}$ *&c. v. g.*

$$\frac{aabb}{ddd} = \frac{ab}{\sqrt{ddd}.}$$

Of Surds.

They are ſuch numbers as can't be exactly expreſs'd in figures, and are call'd *irrational numbers.*

Their reductions were formerly difficult, but now are uſeleſs, and decimal arithmetic has rendred them more capable of exact expreſſion.

N. B. $\frac{\sqrt{ba}}{+\sqrt{ba}} = \sqrt{ba}$ and $\frac{\sqrt{bc}}{\times\sqrt{bc}} = \sqrt{bc}$ } 'Tis not $\sqrt{2bc}$, ot $\sqrt{b^2c^2}$; but both are $\sqrt{bc}$ only.

Addition, Substraction.

1. If they be homegeneal ſurds, ſubſtract the rational part, and to their ſum or difference join the ſurd, *v. g.*

Addition.

$5\sqrt{bc}$	$6b\sqrt{ac}$	$b\sqrt{aa+cc}$
$7\sqrt{bc}$	$4b\sqrt{ac}$	$3b\sqrt{aa+cc}$
$=12\sqrt{bc}$	$=10b\sqrt{ac}$	$=4b\sqrt{aa+cc}$

Subſtraction.

Subſtraction.

$12\sqrt{bc}$	$10\,b\sqrt{ac}$	$4\,b\sqrt{aa+cc}$
$7\sqrt{bc}$	$4\,b\sqrt{ac}$	$3\,b\sqrt{aa+cc}$
$=5\sqrt{bc}$	$6\,b\sqrt{ac}$	$b\sqrt{aa+cc}$

2. If the ſurds be heterogeneal, add or ſubſtract according to the ſigns, *v. g.*

Addition.

$\sqrt{bc}$	$4\,d\sqrt{}$
$\sqrt{ba}$	$2\,b\sqrt{a}$
$\sqrt{bc+ba}$	$4\,d\sqrt{a+2\,b\sqrt{ac}}$

Subſtraction.

$\sqrt{bc}$
$\sqrt{ba}$
$=\sqrt{bc}-\sqrt{ba}$

MULTIPLICATION.

1. If the ſurds be homogeneal, multiply them together, *v. g.*

$$\sqrt{ba}\times\sqrt{ba}=\sqrt{ba}.$$

2. If they be heterogeneal ſurds, then multiply the rational part with the rational, and the ſurds into the ſurds, *v. g.*

$$\begin{array}{r} d\sqrt{bc} \\ 3\,b\sqrt{bca} \\ \hline 3\,db\sqrt{bca} \end{array}$$

DIVISION.

1. If they are pure ſurds and of the ſame kind, divide off and add the radical ſign, *v. g.*

$\div\sqrt{ba}$	$\sqrt{bc\,aa+dc\,aa}$
$\div\sqrt{ba}$	$\sqrt{ca}$
$=\sqrt{1}$ or $\sqrt{1\,ba}$	$=\sqrt{ba+da}$

} ſee common diviſion.

2. If rationals and irrationals be join'd, then divide the rational by the rational and the ſurd by the ſurd, with adding the radical ſign, *v. g.*

$3\,db\sqrt{bca}$	*N. B.* If a ſquare be divided by its root, the Quotient is its root, *v. g.*
$\div 3\,b\sqrt{a}$	$\frac{aa}{\sqrt{a}}=\sqrt{a}$
$d\sqrt{bc}$	

INVOLUTION.

1. Involve as uſual, *v. g.* $\sqrt{a}=a$.
2. If rationals and ſurds are mixed, involve all, *v. g.*

$b\sqrt{a}$	$5\sqrt{ca}$
$bb\,a$	$=25dd\,ca$

To

To reduce Equations.

By Addition.

Transpose a negative to the other side with the sign + for −, *v. g.* $a-b=d$; then $a=d+b$.

By Substraction.

Transpose a positive to the other side with the sign − for +, *v. g.* $a+b=d$, then $a=d-b$.

By Multiplication.

Multiply every term with the denominators, *v. g.*

$\frac{a}{5}=6$, then $a=5\times 6$.

By Division.

Divide the whole equation by the quantity (known or unknown) if it be in every term of the equation, *v. g.*

$\left.\begin{matrix} baa+bca \\ \div \quad a \end{matrix}\right\} (=ba+bc$ $aa=7a$; $a=7$, then $aa=a$.

By Involution.

Involve as usual, *v. g.* $\sqrt{a}=\sqrt{d+c}$, then $a=d+c$; if root a be $=6$; then $a=36$.

By Evolution.

Evolve as usual, *v. g.* $aa=36$, then $a=6$.

But as evolution is difficult in compound quantities, I shall give different methods of evolving.

Raphson's *method for simple equations*, $a=g+x$.

$aa=c$	$x=\frac{c-gg}{2g}$	$a=\frac{c+gg}{2g}$
$aaa=d$	$x=\frac{d-ggg}{3gg}$	$a=\frac{d+2ggg}{3gg}$
$aaaa=f$	$x=\frac{f-g^4}{4g^3}$	$a=\frac{f+3g^4}{4g^3}$
$a^5=f$	$x=\frac{f-g^5}{fg^4}$	$a=\frac{f+4g^5}{5g^4}$

$a=g+x$; then $aa=gg+2gx+g^2$. $=c$. $=2$.; now take $g=1$; then $x=\frac{2-1}{2}=.5=\frac{1}{2}$; then $g+x=1.5=2^d g$. then $\frac{2-2.25}{3}=.083$. then $1.5-.083=1.417=3^d g$. then $x=\frac{2-2.007889}{2.834}=-.002783$. then $1.417.=1.414217.=4^{th} g$. &c.

His method for adfected equations.

$aa + ba = c$	$x = c - \frac{gg - bg}{2g + b}$
$aa - ba = c$	$x = c - \frac{bg - gg}{2g - b}$
$ba - aa = c$	$x = c - \frac{gg - bg}{b - 2g}$
$a^3 + ca = d$	$x = d - \frac{g^3 - cg}{3g^2 + c}$
$ca - a^3 = d$	$x = d + \frac{g^3 - cg}{c - 3gg}$
$a^3 + ba^2 + ca = d$	$x = d - \frac{g^3 - bg^2 - cg}{3gg + 2bg + c}$
$a^3 + ba^2 - ca = d$	$x = d - \frac{g^3 - bg^2 + cg}{3g^2 + 2bg - c}$
$a^3 - ba^2 - ca = d$	$x = d + \frac{bg^2 + cg - g^3}{3g^2 - 2bg - c}$
$ba^2 + ca - a^3 = d$	$x = d + \frac{g^3 - bg^2 - cg}{2bg + c - 3g^2}$

Dr. Harris's *method*; $R = 36$. $d = 16$.

In quadratics

$aa + da = R$; then $\sqrt{R + \frac{1}{4}dd} - \frac{1}{2}d = a$ the greater,
and $a + \frac{1}{2}d = e$ the leſſer.

$aa - da = R$. then $\sqrt{R + \frac{1}{4}dd} + \frac{1}{2}d = a$ greater.
and $a - \frac{1}{2}d = e$ leſſer.

$sa - aa = R$. then $\sqrt{\frac{1}{4}ss - R} + \frac{1}{2}d = a$ greater.
and $a - \frac{1}{2}d = e$ leſſer.

His

His method of approximation, or converging, from Dr. Wallis, *in ſurds.* *N. B.* $2ac+cc=b$.

$aa+2ae+ee=N$, then $N-a^2+\frac{b}{2a}=$ or $N-a^2+\frac{b}{2a}+1=\sqrt{}^2 N=5$; then $\sqrt{}^2 5=2\times 2=4+1\div 4=2+\frac{1}{4}$; or $\sqrt{}^2 5=2+\frac{1}{4}$, and proceeding by decimals as above, we come to an exact nearneſs.

In cubes 'tis $N-a^3+\frac{b}{3aa}=\sqrt{}^3$

In biquadrates $N-a^4+\frac{b}{4a^3}=\sqrt{}^4$

In ſurſolids $N-a^5+\frac{b}{5a^4}=\sqrt{}^5$ *&c.*

Dr. Halley's *method of approximation*, v. g.

His rational Theorem is $x=\frac{b}{c+\frac{bd}{c}}\Big\}\frac{1}{3+\frac{3}{3}}=\frac{1}{4}=.25.$

His irrational theorem is $x=\frac{bd+\frac{1}{4}cc'\frac{1}{2}-\frac{1}{2}c}{d}\Big|=3+2\frac{1}{4},\frac{1}{2}$ $\Big|=\frac{1}{2}=26$

.25 may be too little, .26 too much.

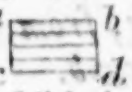
I have given one example of *approximation* or *converging ſeries*, and to give more would be unintelligible, unleſs the readers were acquainted with the nature of decimals, which muſt be deferr'd, till a fitter occaſion; wherefore I ſhall deſcend to the operations of fluxions.

Of FLUXIONS.

They are called the *calculus differentialis*, becauſe they meaſure very ſmall parts.

Fluxions are quantities as deſcribed by a continued, uninterrupted, motion; not as conſiſting of very ſmall parts; they are the *reſult of a regular flux.*

Thus a *line*'s deſcribed, that is, generated, by the continual motion of a point, *v. g.* .....

Thus a *ſurface* is generated by the continual motion of a line, *v. g.*  from *a b* to *c d*.

Thus a *ſolid* is generated by the continual motion of a ſurface, *v. g.* from *a b c d* to *e f g h*.

A *point* is moved with a ſimple or compound motion, and then it deſcribes a line or lines.

A *line* is moved with a ſimple and compound motion, and makes a ſurface.

If points be moved ever regularly proportional, the ſpaces deſcribed make a right line.

If two points be not proportional, then the line is a curve, concave, or convex.

Curves are either ſuch, whoſe ordinates are parallel to one another, as a parabola, a circle; or which meet in a point, as ſpirals; as to our preſent purpoſe, the velocity of the two motions is conſidered: if one be uniform (equable) and the other accelerated, 'tis a curve.

The velocity then is variable in every point of the curve, and infinitely.

Velocity is fluxion, but not increments; velocities are conſidered then as *incrementa naſcentia* or *evaneſcentia*, not as increments themſelves; the *incrementa naſcentia* are called the *firſt ratio*, and the *incrementa evaneſcentia*, the *ultimate ratio*.

There are *fluxions* or velocities, and *fluents* or flowing quantities.

Fluents or flowing ſpace (x,xx) $=a$	a	$2a$	$3a$	$4a$	&c.	$=A$
Time $=t$	$=t$	$2t$	$3t$	$4t$	&c.	T
Conſtant velocity $=u$	$=u$	$2u$	$3u$	$4u$	&c.	$v.$
Fluxion = mutable velocity $=\dot{v}$	v	u	x	y	&c.	$\dot{V}$

N. B. All compariſons muſt be made between things of the ſame ſpecies; *v. g.* between lines and lines; ſurfaces and ſurfaces; ſolids and ſolids; not between lines and ſurfaces; or between ſurfaces and ſolids; thus *v. g.* motion being compounded of matter and velocity, motion can't be compar'd with matter alone.

ADDITION.

Put a point over the letter, *v. g.* the fluxion of x is $\dot{x}$; of y is $\dot{y}$, &c.

SUB-

SUBSTRACTION.

Take away the point, *v. g.* $\dot{x}$ is x; $\dot{y}$ is y.

MULTIPLICATION.

Multiply the fluxion of each ſimple quantity by the factors of the products (or the product of all the reſt) and connect the laſt products by their proper ſigns; the ſum (or aggregate) is the fluxion ſought, *v. g.*

$$x\,y = \dot{x}\,y + \dot{y}\,x \text{ ſc.} \times \begin{matrix} x\,y \\ \dot{y}\,\dot{x} \end{matrix} = \dot{y}\,x + \dot{x}\,y \text{ or}$$

$$x\,y\,z. = \times \begin{matrix} x\,y\,z \\ \dot{x}\,\dot{y}\,\dot{z} \end{matrix} = \dot{x}\,y\,z,\ x\,\dot{y}\,z,\ + x\,y\,\dot{z}.$$

DIVISION.

If each number of the fluxion be divided by the fluxionary letter (or quantity) if you change the fluxionary letter into that proper flowing quantity, of which 'tis the fluxion, 'tis done, *v. g.*

$$\frac{\dot{x}\,y + x\,\dot{y}}{\dot{x} \quad \dot{y}} = y\,x \text{ or } x\,y.$$

INVOLUTION, or *to find the fluxion of any power.*

Multiply the power, brought one degree lower, by the index of that firſt power; and then that product by the fluxion of the root, *v. g.*

x^m is x^{m-1} then $m\,x^{m-1}$ then $m\,x^{m-1}\,\dot{x}$ } ſc. x^m; x^{m-1}; $m\,x^{m-1}$; $m\,x^{m-1}\,\dot{x}$

EVOLUTION, or *to find the fluent or flowing quantities belonging to the fluxion of any power,* v. g. $3\,xx\dot{}$, *thus*

1. Take away the fluxionary letter	$3\,xx$	Rule 1.
2. Augment the index by unity	$3\,xxx$	Rule 2.
3. Divide by the index of its power ſo increaſed by unity	$\frac{xxx}{3}$	Rule 3.

ſs.

$$\frac{n}{m} x \frac{n-1}{m} \quad \text{Rule 1.}$$

$$\frac{n}{m} x \frac{n}{m} \quad \text{Rule 2.}$$

$$\frac{\frac{n}{m} x \frac{n}{m}}{\frac{n}{m}} \quad \text{Rule 3.}$$

$$\int \dot{x} x \frac{n}{m} \frac{n-1}{m}$$

N. B. Addition, multiplication, involution, are called the *direct method*; but ſubſtraction, diviſion, and evolution, the *inverſe method.*

To find the fluxion of any fraction.

Divide and take away the point, *v. g.*

$$\frac{\dot{N}D - N\dot{D}}{DD} = ND.$$

for

$\dot{N}D - N\dot{D} \div DD.$ 1ſt.

$-D\dot{N} \div DD = N.$ 2ly.

$-N\dot{D} \div DD = D$ 3ly.

$$\frac{\dot{x}y - x\dot{y}}{yy} = \frac{x}{y}$$

The new manner of Notation.

$\sqrt[3]{108} = \sqrt[3]{27 \times 4}.$

$3\sqrt[3]{4} = \sqrt[3]{27 \times 4}.$

$\frac{n}{2}$ = ſquare of n power.

$2n + 1$ power = the power of twice $n + 1$.

$x^{\frac{1}{2}} = \sqrt{x}$; $\dot{x}^{\frac{1}{3}} = \sqrt[3]{x}$;

$x^{\frac{4}{5}} = \sqrt[5]{}$ of x^4.

$\frac{1}{x} = x^{-1}$; $\frac{3}{x} = x^{-3}$

$x^{\frac{3}{4}}$ = biquadrate $\surd$ of the cube.

$x-3$ = unity $\div$ by the cube of x.

$x^{-\frac{1}{7}}$ = unity $\div$ by the $\surd^3$ of the 7th power of x.

$x^{\frac{1}{2}} + \frac{1}{3} = x^{\frac{1}{2}} \times x^{\frac{1}{3}} = x^{\frac{5}{6}}$.

$x^{\frac{1}{2}} - \frac{1}{3} = x^{\frac{1}{2}} \div x^{\frac{1}{3}}$.

$\frac{1}{N^{2p}} = N^{-2p}$.

$x^{\frac{1}{5}}$ = ſub 5 tuplicate $\surd$ or $\surd$ of x^5.

$x^{\frac{2}{5}}$ = ſub 5 tuplicate $\surd$ or $\surd$ of x^2.

$x^{\frac{1}{4}}$ = ſub 5 druplicate $\surd^4$.

$x^{\frac{4}{5}}$ = ſub 5 tuplicate of x^4.

Some

Some uſes to which Algebra and Fluxions are applicable.

They are uſeful in the rules of proportion, *v. g.*

In the direct.	*In the inverſe.*
$a : b :: c : d.$	
$4 : 6 :: 8 : 12.$	
$1^t = \frac{2^d \times 3^d}{4}$	$1^t = \frac{3^d \times 4^{th}}{2^d}$
$2^d = \frac{1^t \times 4^{th}}{3^d}$	$2^d = \frac{3^d \times 4^{th}}{1^t}$
$3^d = \frac{1^t \times 4^{th}}{2^d}$	$3^d = \frac{1^t \times 2^d}{4^{th}}$
$4^{th} = \frac{2^d \times 3^d}{1^t}$	$4^{th} = \frac{1^t \times 2^d}{3^d}$

As alſo in the compound Rule of Three, *v. g.*

	Direct Rule.	*Inverſe.*	
L P T W l p t w	$LBT : W :: lbt \frac{wlbt}{LBT} = W$	$\frac{LBT \times W}{lbt} = w$	M T P m t p
Length Breadth Thickneſs Weight	M : T : P m . t ; p? $MT : P :: mt : \frac{Pmt}{MT} = p$	$\frac{MT \times P}{mt} = p.$	Mean Time Pounds

The direct Rule of Three, is when more requires more.

The inverſe or reciprocal, when more requires leſs; and leſs, more.

Theſe *Rules of Three* are expreſſed thus.

Direct. If 4 yards coſt 6 *s.* what will 8 coſt?

If a body 2 feet long, 1 foot broad, and 3 feet thick, weighs 5 pound, what will a body 3 feet long, 2 feet broad, and 4 feet thick, weigh, *&c?*

Direct may be made inverſe, and *inverſe* direct at pleaſure.

The Rule of Fellowſhip.

Suppoſe O = total depoſited = 150 *l.* N = loſs or gain = 60 *l.* A, B, C, D, E, = each man's ſum depoſited (*ſc.* = 50, 40, 30, 20, 10.) then

$O : N$

$O : N ::$ $\left\{ \begin{array}{l} A : \frac{NA}{O} \\ B : \frac{NB}{O} \\ C : \frac{NC}{O} \\ D : \frac{ND}{O} \\ E : \frac{NE}{O} \end{array} \right.$ $150 : 60 :: \frac{50 \times 60}{150} = 2$ for *A*, &c.

These are the answers if they deal without reckoning time; but if they reckon in time, then

$O : N ::$ $\left\{ \begin{array}{l} Aa : \frac{NAa}{O} \\ Bb : \frac{NBb}{O} \\ Cc : \frac{NCc}{O} \\ Dd : \frac{NDd}{O} \\ Ee : \frac{NEe}{O} \end{array} \right.$

Arithmetic Progression (by Addition.)

$a =$ 1st term
$y =$ last term
$e =$ common excess

$N =$ all the number of terms
$S =$ sum of all the terms.

v. g.

2, 4, 6, 8, 10, 12, 14, 16, 18, 20.

$a = \frac{2S - Ny}{N}$ $\quad$ $N = \frac{2S}{a + y}$

$y = \frac{2S - Na}{N}$ $\quad$ $S = \frac{Na + Ny}{2}$

$e = \frac{y - a}{N - 1}$

Geometric

Geometric Progreſſion (by Multiplication.)

a = 1ſt term | S = ſum of all.
y = laſt term
e = common exceſs | then

2, 4, 8, 16, 32, 64, 128, *&c.*

$a = s + ey - es$ | $y = \frac{eS + a - s}{e}$

$e = \frac{s-a}{s-y}$

$S = \frac{ey-a}{e-1}$

N. B. This is the rule for combinations and permutations; and permutation is double to combination.

By theſe combinations, we come at the chances in games, changes of bells and muſic; at the changes in a word, for anagrams, *&c.* *v. g.*

1	1
2	2
3	6
4	24
5	120
6	720

So that in 6 bells, there are 720 changes, *&c.*

Fifteen queſtions anſwered from Mr. Ward.

Suppoſe *the ſum* $= a + e = S = 240$
The difference $= a - e = D = 192$
The quotient $= a \div e = Q = 9$
The product $= a \times e = P = 5185$
The ſum of the ſquare $= aa + ee = Z = 47232$
The difference of the ſquare $= aa - ee = X. 46080$

Then given $s + d$; $a = \frac{s+d}{2}$; $e = \frac{s-d}{2}$; $p = \frac{ss-dd}{4}$; $Q = \frac{s+d}{s-d}$; $Z = \frac{ss+dd}{2}$; $X = s\,d^2$.

2. *Given* $s + p$. $a = \frac{s \times \sqrt{ss-4p}}{2}$; $e = \frac{s-\sqrt{ss-4p}}{2}$; $d = \sqrt{ss-4p}$; $q = \frac{s+\sqrt{ss-4p}}{s-\sqrt{ss-4p}}$; $Z = ss - 2p$; $x = s\sqrt{ss-4p}$.

3. Given s and q. $d=\frac{qs-s}{q+1}$; $z=\frac{qq\,ss+s^2}{qq+2q+1}$; $x=\frac{qq\,ss-ss}{qq+2q+1}$; $p=\frac{q\,ss}{qq+2q+1}$; $a=q\,e$; $e=s-q\,e$.

4. Given s and z; $d=\sqrt{2z-ss}$; $a=\frac{s+\sqrt{zz-ss}}{2}$; $e=\frac{s-\sqrt{2z-ss}}{2}$; $p=ss$; $q=\frac{s+\sqrt{ss-4p}}{s-\sqrt{ss-4p}}$ $x=s\sqrt{es-4p}$.

5. Given $s+x$; $a=\frac{ss+x}{2s}$; $e=\frac{ss-x}{2s}$; $d=\frac{x}{s}$; $p=\frac{s^4-x^2}{4ss}$; $q=\frac{ss+x}{ss-x}$; $z=\frac{s^4+x^2}{2ss}$.

6. Given $d+p$; $a=\frac{d+\sqrt{d^2+4p}}{2}$; $e=\frac{\sqrt{d^2+4p}}{2}-d$; $s=\sqrt{dd+4p}$; $q=\frac{d+4\,dd^2+4p}{\sqrt{d^2+4p}-d}$; $z=dd+2p$; $x=d\sqrt{d^2+4p}$.

7. Given $d+q$; $a=\frac{q\,d}{q-1}$; $e=\frac{d}{q-e}$; $s=\frac{q\,d+d}{q-1}$; $p=\frac{q\,dd}{qq-2q+1}$; $z=\frac{q^2\,d^2+d^2}{q^2-2q+1}$; $x=\frac{q^2\,d^2-d^2}{q2-2q+1}$.

8. Given $d+z$; $a=\frac{d+\sqrt{2z-d^2}}{2}$; $e=\frac{\sqrt{2z-d^2}}{2}$; $s=\sqrt{2z-d^2}$; $p=\frac{z-d^2}{2}$; $q=\frac{d+\sqrt{2z+d^2}}{\sqrt{2z-d^2}-d}$; $x=d\sqrt{2z-dd}$.

9. Given $d+x$; $a=\frac{dd+x}{2d}$; $e=\frac{x-d^2}{2d}$; $s=\frac{x}{d}$; $p=\frac{x^2-d^4}{4dd}$; $q=\frac{d^2+x}{x-d^2}$; $z=\frac{d^4+x^2}{2d^2}$.

10. Given $p+q$; $a=\sqrt{qp}$; $e=\frac{\sqrt{p}}{q}$; $d=\sqrt{qp}-\frac{\sqrt{p}}{q}$; $z=qp+\frac{p}{q}$; $x=qp-\frac{p}{q}$.

11. Given $p+z$; $a=\frac{\sqrt{z+2p}+\sqrt{z-2p}}{2}$; $d=\sqrt{z-2p}$; $e=\frac{\sqrt{z+2p}-\sqrt{z-2p}}{2}$; $q=\frac{\sqrt{z+2p}+\sqrt{z-2p}}{\sqrt{z+2p}-\sqrt{z-2p}}$; $x=\sqrt{z^2-4p^2}$.

12.

12. *Given* $p+x$; $a=\sqrt{x+\sqrt{x^2+4p^2}}$; $z=\sqrt{x^2+4p^2}$; $e=\frac{\sqrt{x^2+4p^2}-x}{2}$; $s=\frac{\sqrt{x^2+4p^2}-x}{2}$.

13. *Given* $q+z$; $a=\frac{\sqrt{q^2z}}{q^2+1}$; $e=\sqrt{\frac{z}{q^2+1}}$; $d=\frac{\sqrt{q^2z}}{q^2+}$: $\frac{-\sqrt{z}}{q^2+1}$; $s=\sqrt{\frac{q^2z}{q^2+1}}+\sqrt{\frac{z}{q^2+1}}$; $x=\frac{q^2z-z}{q^2+1}$ $p=\sqrt{\frac{qqzz}{q^4+2q^2+1}}$,

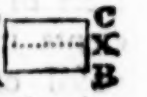
14. *Given* $q+x$; $a=\sqrt{\frac{q^2x}{q^2-1}}$; $e=\sqrt{\frac{x}{q^2-1}}$; $d=\frac{\sqrt{q^2x}}{q^2-1}$ — $\frac{1-x}{q^2-1}$; $p=\sqrt{\frac{q^2x^2}{q^4-2q^2+1}}$; $z=\frac{q^2x+x}{q^2-1}$; $s=\sqrt{\frac{q^2x}{q^2-1}}+$ $\frac{\sqrt{x}}{q^2-1}$.

15. *Given* $z+x$; $a=\frac{\sqrt{z+x}}{2}$; $e=\frac{z-x}{2}$; $d=\frac{\sqrt{z+x}}{2}-\frac{\sqrt{z-x}}{2}$; $p=\frac{\sqrt{z^2-x^2}}{4}$; $q=\frac{\sqrt{z+x}}{\sqrt{z-2}}$; $s=\frac{\sqrt{z+x}}{2}+\frac{\sqrt{z-x}}{2}$.

All the queſtions on intereſt are anſwer'd by the rule of proportion.

The area of a parallelogram got by fluxions.

Let AB=a; BC=x; the fluxion of BC will be $\dot{x}$, which being multiplied by $a=a\dot{x}$. AB is ſtable and neither increaſes nor decreaſes; and when B is arrived at C it grows no more then $a\dot{x}$ is ax, becauſe the fluxion ceaſes.



The area of a parabola by fluxions.

$px=yy$; $x^{\frac{1}{2}}=y$; $x^{\frac{1}{2}}\dot{x}=\dot{A}$; $\dot{x}x^{\frac{1}{2}}-x=x^{\frac{1}{2}}$; $x^{\frac{1}{2}}+x=xx^{\frac{1}{2}}$; $\frac{xx^{\frac{1}{2}}}{1+\frac{1}{2}}=\frac{2}{3}\frac{xx^{\frac{1}{2}}}{1}=\frac{2xx^{\frac{1}{2}}}{3}$, for $x^{\frac{1}{2}}$ put y its equal, then

$\frac{2}{3}xy=\frac{1}{2}$ area, double this and you have the whole area. *See Evolution in Fluxions.*

Theſe few examples are ſufficient to ſhew the great uſes made of this invention.

ARTICLE LVII.

A Compendious Syſtem of NATURAL PHILOSOPHY; *with Notes, containing the Mathematical Demonſtrations, and ſome occaſional Remarks. Part* I, *Conſiſts of three Diſſertations,* viz. 1. *Of the Properties of Bodies.* 2. *Of the Laws of Motion, and* 3. *Of the Mechanical Powers. By* J. ROWNING, *M. A. Fellow of* Magdalen College *in* Cambridge. London, *Printed for the Author; and ſold by* S. Harding, *Bookſeller, on the Pavement in* St. Martin's-Lane, 1736. Octavo. *Containing* 75 *pages.*

THIS learned author wrote this firſt part in 1734, and in 1736 publiſh'd a ſecond edition of it with a few alterations. In the *introduction* he juſtly obſerves, that a great part of ancient and modern philoſophers, in ſearching into nature, neglected the uſe of geometry and experiment, the only two helps in finding out cauſes, and proportioning them to their effect; and gave bodies ſuch certain *arbitrary* properties as beſt ſerved their purpoſe in accounting for the *phænomena* of nature, whence proceeded ſo many various ſects of philoſophers. The ancients imagin'd all bodies compoſed of *air*, *earth*, *fire*, and *water*, or ſome one or more of theſe; whence the name of principles or elements is ſtill retain'd. *Epicurus* aſſerted, tho' bodies conſiſted of one or more of theſe, yet they were not ſtrictly elements, but that they themſelves conſiſted of *atoms*, by an accidental concourſe of which all things receiv'd their form and exiſtence.

DES CARTES ſuppoſed the univerſe at firſt full of matter, from this matter, when firſt put in motion, ſome particles would be rubbed off fine enough to paſs through the moſt ſolid bodies without reſiſtance; of theſe conſiſts his *materia ſubtilis*, or *materia primi elementi*. He imagined globular particles would from hence reſult, which he denominated *materia ſecundi elementi*. Thoſe, which ſo far retained their figure as not to come under the denomination of *materia primi* or *ſecundi elementi*, he called *materia tertii elementi*, and ſuppos'd GOD created a certain quantity of motion, and allotted to this material maſs, which therefore can be no more annihilated without an omnipotent hand, than the body itſelf, and that the quantity of motion is always the ſame. The preſent method of philoſophizing is to find out the laws of nature by experiments and obſervations, with a proper application to geometry. This way of ſearching into nature was propoſed by my lord *Bacon*, proſecuted by the *Royal Society*, the *Royal Academy* at *Paris*, Mr. *Boyle*, Sir *Iſaac Newton*, &c.

The PROPERTIES of BODIES are, 1. Solidity. 2. Extenſion. 3. Diviſibility. 4. A capacity of being mov'd from place to place. 5. A paſſiveneſs, or inactivity.

Vacuum

Vacuum is a place void of matter; matter affords a reſiſtance nearly in proportion to its denſity. The motions of the comets, the different weight of bodies of the ſame bulk, *&c.* are arguments to prove this.

Attraction and *Repulſion* are, perhaps, not eſſential properties of matter, but impreſſed on it.

Attraction is of two kinds, 1. *Coheſion.* 2. *Gravitation.* The attraction of coheſion is proved by letting a ſmall glaſs tube, open at both ends, be dip'd into a veſſel of water, the water will immediately riſe in the tube to a certain height above the level. The heights, the water riſes to in different tubes, are reciprocally as the diameters of the tubes; for, ſuppoſe there be two tubes, the diameter of the firſt is double to that of the ſecond, the water will riſe half as high in the firſt as in the ſecond; therefore ſince it is found to riſe but half as high, the quantity is but twice as much, and therefore as the diameter.

Attraction by coheſion acts only upon contact, or at very ſmall diſtances; and alſo acts according to the breadth of the ſurfaces of the attracting bodies. It decreaſes much more than the diſtances of the attracting bodies increaſe; that is, whatever the force of attraction is at a given diſtance at twice, that diſtance ſhall be more than four times leſs than before. Hence we may eaſily account for the different degrees of hardneſs in bodies; for thoſe whoſe conſtituent particles are flat or ſquare, and touch in many points, will be hard; thoſe more round, and touch in fewer points, will make a ſofter body; thoſe ſpherical will form a fluid.

Attraction of *Gravitation* decreaſes as the ſquares of the diſtances between the centers of the attracting bodies increaſe; but the truth of this propoſition is not to be had from experiments. Bodies attract one another with forces proportionable to the quantities of matter they contain. The weight of a body is the ſame whether it be whole or ground to powder; and the gravity of a body increaſes in proportion as it approaches the center. The diſtances of each particle of matter from the body will be as the diameter of the ſphere, or as the radius and their action inverſely as the ſquare of the diſtance, but the quantity of matter will be as the cube of that diſtance.

A body gravitates to another which moves toward it. When we uſe the terms *attraction* or *gravitation*, we do not thereby determine the phyſical cauſe of it.

Repulſion is another property in bodies, which is juſt placed beyond the ſphere of each other's attraction of coheſion, they mutually fly from each other: but it is poſſible to preſs or force the repelling bodies into the ſphere of each other's attraction.

Beſides theſe general properties, ſome bodies are endued with another called *electricity*, as amber, jet, *&c.* But theſe bodies only act when heated. 2. They act more forcibly when heated by rubbing them than by fire. 3. When well heated by rubbing, light bodies will be alternately attracted and

and repelled by them. 4. If a line, 500 yards in length, have a ball ſuſpended at one end, and the other be fixed to a glaſs tube, when the tube is heated by rubbing, the electrical virtue of the glaſs will be communicated from the tube to the ball, which will attract and repel light bodies as the glaſs does. 5. If the glaſs tube be emptied of air it loſes its electricity. The load-ſtone has peculiar properties whereby it attracts and repels iron. Solution of the properties of electricity and magnetiſm have been attempted, but as yet very unſatisfactory.

The LAWS of MOTION.

LAW I. *All bodies continue their ſtate of reſt or uniform motion in a right line, till made to change that ſtate by ſome external force impreſſed on them.*

LAW II. *The change of motion is always proportionable to the force whereby it is effected, and the effect is always in proportion to its cauſe.*

LAW III. *Re-action is always contrary and equal to action.*

Theſe laws are hence fully proved, *viz.* That all the concluſions drawn from them, in relation to the *phænomena* of bodies, how complicated ſoever their motions be, are always found perfectly to agree with obſervation.

The ſpaces bodies fall through in different times are as the ſquares of thoſe times; and the ſpace a body paſſes over, with an uniform motion, is in a *ratio* compounded of the time and velocity. The ſpaces deſcribed by falling bodies in different times are as the ſquares of the laſt acquired velocities; and the ſpace a body paſſes over, from the beginning of its fall in any determinate time, is half what it would deſcribe in the ſame time, moving uniformly with its laſt acquired velocity. When bodies are thrown up perpendicularly their velocities decreaſe, as the times they aſcend in increaſe; and the heights bodies riſe to, when thrown perpendicularly upward, are as the ſquares of the times ſpent from their firſt ſetting out, to the moment they ceaſe to riſe.

When a body deſcends on an oblique plane, its motion is continually accelerated by the action of gravity, but in a leſs degree than when it deſcends perpendicularly, its free deſcent in this caſe being hindered by the interpoſition of the plane. The effect of gravity upon a body falling down an oblique plane is as much leſs than the ſame acting on another's falling freely, as the perpendicular height of the plane is leſs than its length. A body falls through as much longer ſpace perpendicularly than obliquely in the ſame time, as the oblique ſide of the plane is longer than the perpendicular height; for it is evident, in all motions equally accelerated, the ſum of the velocities produced in any time are as the generating forces. The velocity a body acquires by falling perpendicularly as much exceeds that which it acquires by falling obliquely in the ſame time, as the ſpace of its perpendicular

perpendicular deſcends in that time exceeds that of its oblique one; and a body takes up as much more time in falling down the oblique ſide of a plane than it does its perpendicular height, as the oblique ſide exceeds the height. A body acquires the ſame velocity in falling down the oblique ſide of a plane, as if it fell through its perpendicular height. A body takes up the ſame time in falling through the chord of a circle, as it does in falling perpendicularly through the diameter of the ſame circle. Upon this is founded the theory of pendulums. Hence the reaſon why the ſhorter arches a pendulum deſcribes the nearer its vibrations come to an equality. The time of the deſcent and aſcent of a pendulum, is equal to the time in which a body falling freely would deſcend through eight times the length of the pendulum; for the deſcent alone is equal to that in which a body would fall through the diameter of the circle; and the times, pendulums of different lengths perform their vibrations in, are as the ſquare roots of their lengths. The ſquares of the times in which pendulums, acted upon by different degrees of gravity, perform their vibrations in, are to each other as the gravities. Whence a pendulum will vibrate ſlower when nearer the equator, than the ſame when nearer the poles; for the gravity of all bodies is leſs the nearer they are to the equator.

A body projected in a direction parallel or oblique to the horizon would proceed, *ad infinitum*, in a right line, but being continually accelerated toward the earth by its gravity, will deſcribe a parabola; and the greateſt diſtance a body can be thrown is at the elevation of 45 degrees. This affords an eaſy method of finding what direction is neceſſary to throw a ball in with a given velocity to ſtrike an object in a given ſituation. If two balls are thrown at different elevations, but with equal degrees of velocity, the one as much above 45 degrees as the other is below, the horizontal diſtances where they both fall will be the ſame; and the height a body will riſe to, when thrown perpendicularly upward, is equal to half the greateſt horizontal diſtances it can be thrown to with the ſame velocity. Hence we eaſily know how far a mortar-piece, or other ſuch machine, will carry a ball. The diſtances of two projectiles, having the ſame degrees of elevation, but thrown with different velocities, are as the ſquares of the velocities.

Note, Experiments, relating to the motion of projected bodies, do not exactly anſwer the theory, the reſiſtance of the air deſtroying part of their motion; therefore a ſmall allowance is to be made.

When a body revolves about another ſo, that the force by which it is prevented from flying off is called the *centripetal*, the counter-action of this the *centrifugal*; theſe, being equal to each other, are called *central forces*; that with which the body is at firſt projected, is the *projectile* force, and the time, in which it performs one revolution, the *periodical* time.

As to the *communication of motion*; the more matter a body contains

contains, the greater will be its motion, tho' its velocity remains the ſame. The *momentum* or force depends equally on the quantity of matter a body contains, and on the velocity with which it moves; therefore the method of determining how great it is, is by multiplying one by the other.

Inelaſtic bodies are thoſe which do not rebound. When one body impinges another at reſt, the *momentum* in both bodies taken together remains the ſame after impact; that is, the impinging body communicates half its velocity, and keeps half.

Bodies perfectly elaſtic are ſuch as rebound after impact with a force equal to that with which they impinge upon one another. The action of elaſtic bodies on each other is twice as much as the ſame in bodies void of elaſticity. Two equal and elaſtic bodies, the one in motion, the other at reſt, the impinging body will communicate twice as much velocity as if it had not been elaſtic. If one body be elaſtic, and another infinitely hard, the impreſſion in the elaſtic body will be double of what it would have been, had they both been equally elaſtic. The elaſtic power exerts itſelf in one conſtant proportion to the compreſſing force; and the force of impact will be leſs, the more the direction varies from the perpendicular; for a direct impulſe is the greateſt of all. The force of oblique percuſſion is to that of the direct as the ſine of the angle of incidence to the radius; and the force of oblique action is to that of direct, as the coſine of the angle comprehended between the direction of the force, and that wherein the body is to be moved thereby, to the radius. If a body is drawn or impelled three different ways at the ſame time by as many forces acting in different directions, and the quantity of theſe forces is ſuch that the body is kept in its place by them; the forces will then be to each other as the ſeveral ſides of the triangle drawn reſpectively parallel to the directions in which the forces act.

The MECHANICAL POWERS are the *lever*, *wheel*, *axis*, *pulley*, *ſcrew*, and the *wedge*, to which ſome add the *inclined plane*.

The LEVER is a right line or bow, moveable on a center, or fix'd point. The equilibrium in this machine is, when the diſtance of the power from the fixed point is to that of the weight from the ſame, as the quantity of matter in the weight to that in the power. *

The lever is of three kinds. 1. When the fixed point is between the weight and the power. 2. When the weight is between the fixed point and the power. 3. When the power is between the fixed point and the weight.

In all which caſes the equilibrium will be, when their diſtances from the fixed point are ſuch, that their velocities ſhall be inverſely as their quantities of matter; for then, by being at reſt, neither of them will communicate any motion to

* That body which communicates motion to another is called *the power*, and that which receives it *the weight*.

the

the other. In the WHEEL and Axis, the power is applied to the circumference of the wheel, and the weight is drawn up by means of a rope wound about the axis. In this there will be an equilibrium when the weight is to the power as the diameter of the wheel to that of the axis.

The uſe of this machine is to raiſe weights to greater heights than the lever can do, becauſe the wheel is capable of being turned ſeveral times round, which the lever is not, and to communicate motion from one part of a machine to the other; and few compound machines are without it.

The PULLEY is an inſtrument compoſed of one or more wheels, moveable on their axes. A ſimple pulley ſerves only to alter the direction of the power, for the power and weight will both move through an equal ſpace in the ſame time. But in a pulley not fixed, or in a combination of pullies, the equilibrium will be, when the power is to the weight as one to the number of ropes, that paſs between the upper and lower pullies. If the pullies be ſo diſpoſed that each has its own particular rope, the action of the power will be very much increaſed; for here every pulley doubles it, wherefore the power is four times greater with two pullies, eight times with three, ſixteen times with four, &c. For the firſt will move half as faſt as the power, the ſecond half as faſt as that, and ſo on; wherefore the power is doubled by each pulley. The uſe of the pulley is nearly the ſame with that of the wheel and axis, but it is more portable and eaſier to be fixed up.

In the SCREW the equilibrium will be, when the power is to the weight, as the diameter between any two contiguous threads or ſpirals in the ſcrew, to the way deſcribed by the power in one whole revolution.

This machine is of great force, and very uſeful in retaining bodies in a compreſs'd ſtate, becauſe it will not run back, as the three foregoing will when the power is removed. This ariſes from the great friction of thoſe parts in the ſcrew, which, during its motion, ſlide upon thoſe parts at reſt.

The WEDGE is formed by two equal rectangles joined at their lower baſes, and ſeparated at their upper ones by a third, called the *back* of the *wedge*; the other two its *ſides*. In this mechanical power the weight is generally ſo applied as to be made to move in a direction different from that in which it is protended by the wedge; hence mathematicians have differed in determining the power of this machine, ſome conſidering the weight as moved by it in one direction, and ſome in another. Nay, there are ſome who have differed from truth itſelf. We will therefore lay down the ſeveral proportions they have given for determining the power of this machine, and examine them one by one.

1. Some demonſtrate, that the power will be equal to the reſiſtance of the weight, when it bears ſuch a proportion to it, as the breadth of the back of the wedge, to the ſum of the ſide; or, as

half that breadth to one of its ſides. But they who lay down this proportion ſuppoſe the parts, ſeparated from each other by this machine, to recede from their firſt ſituation in directions perpendicular to the ſides of the wedge.

2. Others make it ſomewhat larger, and demonſtrate that it ought to be as half the breadth of the back to the perpendicular height of the wedge. This proportion is alſo true, ſuppoſing the bodies to recede from each other in directions parallel to the back of the wedge; for when the wedge is driven in between them to its whole height, the bodies will have moved through a ſpace equal to half the back of the wedge, and the power through a ſpace equal to its height; conſequently the equilibrium is in this caſe when the power is to the weight as half the back of the wedge is to its height.

3 Some think there will not be an equilibrium in this machine, unleſs the power is to the weight, as the whole breadth of the back to the perpendicular height; but ſuppoſe, as in the laſt caſe, that the bodies to be ſeparated recede from each other in directions parallel to the back of the wedge, and endeavour to ſupport their opinion by the following argument; *viz.* that, when the wedge is drove to its whole height, each part of the weight having moved through a ſpace equal to half the back of the wedge, the whole weight has therefore moved through twice as much, or a ſpace equal to the whole back; that is, the whole has moved farther than its part, which is abſurd.

4. *Graveſande*, in *Element. l.* 1. *cap.* 13. gives the ſame proportion with the laſt, and therefore committed the ſame miſtake; and in *Schol. de ligno findendo* ſays, that when the parts of the wood are no farther ſeparated than the wedge is drove in, the equilibrium will be, when the power is to the reſiſtance, as half the breadth of the back of the wedge to one of its ſides; which is alſo abſurd.

The INCLINED PLANE is only half the wedge; it follows then that what has been demonſtrated of the one may alſo be applied to the other, and the properties of both will be the ſame.

Theſe are the machines, which, under different forms, conſtitute all others how complicated ſoever; and as the equilibrium in any one of theſe is, when the power and weight are inverſely as their velocities; ſo in a machine, however compounded, the power and weight will exactly ballance each other, when in this proportion; for their moments will then be equal, and the machine, if at reſt, will continue in that ſtate; and if moved by any external force, will gradually loſe it when that force ceaſes to act, on account of the inavoidable friction of the machine, and the reſiſtance of the air, which it muſt meet with except its motion could be performed in a perfect vacuum. Hence the impoſſibility of contriving a *perpetual moving engine*, unleſs a force could be gained by the artful diſpoſition and combination of the mechanical powers equal to that continually deſtroy'd by friction and the reſiſtance of the air, which

is

is impoſſible. 'Tis for want of a due conſideration of this, that ſo many mechanical deſigns have proved abortive, ſo many engines unequal to the performance they were deſign'd for, and ſo many impoſſibilities attempted. For, as biſhop *Wilkins* obſerves, [*Mathem. Magic.* p. 104.] was it poſſible to form ſuch an invention, whereby a conceivable weight ſhould be moved by a conceivable power, both with equal velocity, the works of nature would then be under the power of art, and men might thereby be encourag'd to ſuch bold deſigns, as would be fit for an uncreated being. Therefore human arts are ſo confin'd, that what invention has in *ſtrength* of motion, is abated in its *ſlowneſs*; and what it has in the quickneſs of its motion, muſt be allowed in the great ſtrength, requiſite in the power to move it.

ARTICLE LVIII.

TOURNEFORT *continued.*

Ariſtolochia clematitis ruta, creeping birth-wort; the leaves are very bitter, and aromatic; by *analyſis* it gives out acid, oil, earth, an urinous ſpirit, and volatile ſalt; its fixt ſalt yellows ſublimate water; 'tis therefore aperient, ſudorific, deterſive and vulnerary, and good in intermittent fevers: Its root is uſed in vulnerary lotions: it is given in powder and extract: it's uſed in uterine caſes, as an *emmenagogue*.

Arum, or *wake-robbin*; its root is very burning hot, by *analyſis* it yields acid, and volatile ſalt; it is uſed in aſthma's, cachexies, and ſcurvies, obſtructions of the bowels, the plague; it purges alſo; but we ſeldom give it, unleſs in the *Pulvis-ari*, when freſh; which when old, is of no force. In *Poictou* they whiten their linen with it; they cut the ſtalks into little bits, macerate it for three weeks in water; they change it every-day, then dry the *fæces* into a paſte.

Aſarum, *Aſarabacca*, contains a great deal of oily, volatile, aromatic ſalt, loaded with a great deal of ſulphur, acid, and terreſtrial parts. By *analyſis* it affords a great deal of oil and earth, a little urinous ſpirit, no concreted volatile ſalt, but ſeveral acid liquors. *Dioſcorides* ſays, it works upwards and downwards without fatiguing the patients, provokes the *menſes*, is diuretic: a night's infuſion of half an ounce of its roots in wine is a good emetic, in intermitting fevers, the dropſy, gout, ſciatica, all ſorts of looſeneſſes and the dyſentery.

Aſclepias, *ſwallow-wort*; its roots are bitter, acrid, and give a faint red colour to the blue paper; the leaves taſte a little ſaltiſh, and give the ſame paper a fainter red colour, and probably contains a fixed ſalt, involved in a great

deal of ſulphur and earth, and therefore ſhould be ſudorific and deterſive.

Aſter omnium maximus, *Helenium*, *Enula campana*, *elecampane*; it's root is acrid, bitter, a little glutinous, aromatic, gives a faint red to the blue paper, and ſmells like orrice when dry. By *analyſis* it affords, beſide ſeveral acid liquors, a great deal of oil, a little urinous ſpirit, no concreted volatile ſalt. The leaves yield a good deal; ſo that this plant ſeems to act by an oily, volatile ſalt, the *ſal ammoniac* of which is not entirely diſengaged, and is greatly loaded with ſulphur. The root is ſtomachic, pectoral, diuretic, and provokes the *menſes*, uſeful in the jaundice, dropſy, and diſeaſes of the ſkin.

Berberis dumetorum, *Oxyacantha*, the *barberry* or *pipperidge-buſh*. It's root is yellow, bitter, and gives but a faint red colour to the blue paper: the juice gives it as lively a red as allom. This plant *analys'd* yields a great deal of acid liquor, a little urinous ſpirit, and a good deal of oil and earth. The fruit is good to ſtop *diarrhœa's*, *dyſenteries*, and the *whites*, and aſſuages too great a fermentation of bilious humours. *Simon Pauli* makes an eſſential ſalt, which he calls the *tartar* of *barberries*, thus: take, ſays he, two pounds of the juice of *barberries*, and two ounces of *lemon* juice, evaporate them very gently over the fire, ſtrain them, and ſet them to cryſtallize in a cellar: theſe cryſtals are very cooling.

Betonica Vulgaris, *wood betony*. The leaves have an herby taſte, are a little ſaltiſh and aromatic, and gives no tincture of red to the blue paper: the flowers and roots, which are very bitter, ſtain it a little. The *betony* is full of ſulphur, mixed with a little oily volatile ſalt and earth, and by *analyſis* affords a great deal of oil, a little earth and fixed ſalt, no concreted volatile ſalt, but a little urinous ſpirit: 'tis vulnerary, aperitive, diuretic, and good in diſeaſes of the brain. The roots purge upwards and downwards.

Brunella or *Prunella*, *ſelf-heal*, gives a pretty deep red colour to the blue paper; it is of an herby, ſtiptic, and glutinous taſte, mixed with a very little bitterneſs; whence we conjecture, that the acid part of the natural ſalt of the earth is in this plant diſengaged from a good deal of the acrid part, and that being united with abundance of earth and ſulphur, it produces there a ſalt which reſembles allom. 'Tis vulnerary, aſtringent and deterſive, is good in ſpitting of blood, dyſenteries, and all ſorts of hemorrhages.

Bryonia alba, *white bryony*. The leaves are inſipid, glutinous, and give no tincture of red to the blue paper: the root gives it a deep red; it is bitter and of a very ill ſmell: ſo that the acid of the *ſal ammoniac*, which predominates in this plant, ſeems to be more diſengaged in the roots than in the leaves, where it is clogg'd with a great deal more ſulphur. By *analyſis* theſe roots yield a great deal of fœtid oil and acid liquor, and a conſiderable quantity of volatile concreted ſalt. The root, tendrils and ſeeds are powerfully

powerfully cathartic, remove obſtructions and the moſt obſtinate remains of old diſeaſes, and are uſeful in dropſies, gout, epilepſy, aſthma, vapours, palſy, vertigo and the longeſt diſeaſes. The root is given in powder from one ſcruple to two, the juice is drank from two drams to half an ounce, and the decoction from half an ounce to an ounce and half; but in what manner ſoever this root is uſed, it is good to correct it with cream of tartar or vegetable ſalt.

Bugloſſum vulgare, bugloſs. The roots are glutinous, and give a deep tincture of red to the blue paper. The flowers give it but very little, and the leaves hardly any at all: ſo that probably the *ſal ammoniac* in this plant is involved in a glutinous juice, in which the earth and ſulphur predominates. 'Tis cooling, moiſtening, relieves melancholy perſons, diſſipates defluxions of the breaſt and obſtinate coughs.

Burſa paſtoris, ſhepherd's purſe. This plant does not yield much acid by *analyſis*; almoſt all that is extracted from it is alcaline. There are but few plants which yield more concreted volatile ſalt, fixed lixivial ſalt, and earth. Theſe principles mixed together render this plant proper to diſſolve the blood, when it is thickned by foreign acids, which hinder it from paſſing with its ordinary velocity from the arteries into the veins; to which we may refer the greateſt part of defluxions. The earth alſo which is in this plant eaſily imbibes the *ſeroſities*, which occaſion a relaxation of the fibres. All authors hold it aſtringent and vulnerary. Tis believ'd alſo to be febrifugous and lenitive.

Buxus, the *box tree.* The leaves are bitter, have an ill ſmell, and give a faint red to the blue paper. We obtain from the wood, a little acid ſpirit, and a fœtid oil. *Quercetan* reckons it good in epilepſies, vapours, and the tooth-ach.

Calamintha vulgaris, common calamint. This plant is full of an aromatic, oily, volatile ſalt; it is ſtomachic, diuretic, aperitive, and provokes the *menſes*; and muſt be uſed after the manner of tea.

Calendula arvenſis, wild marigold. It's leaves are ſtinking, bitter, and give a faint tincture to blue paper: when burnt in the candle, they crackle a little like nitre, which ſeems to ſhew, that the natural ſalt of the earth is arrived there, with hardly any other change, than being united with a great deal of fœtid ſulphur and earth: it is given in powder, juice, infuſion, extract and conſerve; and all theſe preparations are excellent for the jaundice, palſy, dropſy, ſmall-pox, malignant fevers and green-ſickneſs.

Caprifolium non perfoliatum, common honey-ſuckle. It's leaves are inſipid, ſtiptic, ſtink like a dog-kennel, and give a faint red colour to the blue paper: the roots give it a deeper: it's ſalt reſembles the *ſal ammoniac*, but is united with ſome fœtid oil and earth. A decoction of the leaves is vulnerary and deterſive, good for diſeaſes of the throat, and wounds of the legs.

Carduus

Carduus ſtellatus, *ſtar-thiſtle*. The leaves are very bitter, and give a faint tincture to the blue paper, the root gives it a deeper, and has the taſte of an artichoak. It contains a ſalt very like that which is natural in the earth, for its ſolution is very bitter, and loaded with *ſal ammoniac* and *nitre*: it is likely, that the *ſal ammoniac* predominates in this plant, for the nitre makes no impreſſion upon the blue paper; whereas the *ſal ammoniac* reddens it conſiderably: that which is found in this plant is join'd with a conſiderable quantity of ſulphur and earth; thus the *ſtar-thiſtle* is febrifugous, vulnerary and aperitive. The juice is given in intermitting fevers, at the beginning of the fit, to four or ſix ounces; 'tis alſo good to remove the webs of the eyes, and cures wounds.

Caryophyllata, *avens*. It is bitter, ſtiptic, and gives a deep red colour to the blue paper: its root ſmells like cloves. Its ſalt reſembles the *ſal ammoniac*, but is very much loaded with acid, and involved by a great deal of eſſential oil and earth. 'Tis ſtomachic, de-obſtruent, vulnerary and deterſive.

Cataria, *nep* or *catmint*. It is aromatic, acrid, bitter, and gives no tincture of red to the blue paper; which ſhews it to contain an aromatic, oily, volatile ſalt, in which the urinous part predominates, in the ſame manner as in the artificial, oily, volatile ſalt: this plant taken as tea, or infuſed in wine, is very aperitive, emmenagogic, antihyſteric, and good in the jaundice and violent coughs.

Centaurium minus, *ſmall purple centaury*. The leaves and flowers are very bitter, and for all that they give a conſiderable tincture of red to the blue paper; which makes us conjecture, that the ſalt of this plant is not very different from that which is natural in the earth, which is very bitter: we have the ſame reaſon to believe, that the ſalt of the ſmall *centaury* is mixed with a conſiderable quantity of ſulphur and earth; but in ſuch a manner, that the *ſal ammoniac* is more diſengaged in it than the other principles. The ſalt which is found in the aloes, in the jeſuits bark, and ipecacuana, is much of the ſame nature: for theſe ſubſtances, which are very bitter, give a red colour to the ſolution of turnſole; that is, the aloes a beautiful red, and the two others a gridelin: this plant then ſhould be febrifugous, laxative and aperitive, ſhould kill worms, and re-eſtabliſh the functions of the *primæ viæ*.

Chamæciſſus, *Hedera terreſtris*, *ground-ivy*. The leaves are bitter, a little aromatic, and give hardly any tincture of red to the blue paper: ſo that it is probable its ſalts may in ſome meaſure reſemble vitriolated tartar. This ſalt is mixed with a very little *ſal ammoniac*, but with a great deal of ſulphur and earth: it yields no concreted volatile ſalt by *analyſis*, but a little urinous ſpirit: all the reſt that is obtain'd from it is acid, alcaline, oil and earth, and theſe two laſt are found in great quantity.

tity. 'Tis pectoral, aperitive, deterſive and vulnerary.

Chamædrys minor, germander. The leaves of this plant are bitter and aromatic: they give no tincture of red to the blue paper; the ſalt is not different from that which is natural in the earth, which is a mixture of marine ſalt, nitre, and *ſal ammoniac*; it is acrid, very bitter, and very aperitive: it is probable, that what is found in this plant has loſt it's acrimony by the mixture of a great deal of eſſential oil, which renders the *germander* aromatic: it is febrifugous, ſtomachic, aperitive and diaphoretic.

Chamædrys fruticoſa, five *ſalvia agreſtis, wood-ſage.* It's leaves are very bitter and aromatic, they have a little taſte of garlick, and give hardly any tincture of red to the blue paper; which gives us reaſon to believe they contain a ſalt like that of the *germander*, but loaded with more eſſential oil, and in which the *ſal ammoniac* diſcovers it ſelf but little. This plant is very aperitive, diaphoretic, vulnerary and reſolvent; they uſe it at *Paris* very ſucceſsfully for the dropſy, by giving to drink every four hours a glaſs of the infuſion of this plant in white wine.

Chamædrys paluſtris, ſcordium, water germander. It is bitter, aromatic, and gives a faint red colour to the blue paper: it contains an oily, volatile ſalt, the *ſal ammoniac* of which is not entirely diſengaged, but wrapped up in a great deal of ſulphur. It is a great diſſolver, aperitive, diuretic, ſudorific, good in malignant fevers, ſmall-pox, meaſles, and diſeaſes of the ſkin, and purifies the blood by inſenſible tranſpirations.

Chamæmelum vulgare, camomile. It is bitter, aromatic, and gives a deep red colour to the blue paper: it ſeems to contain ſome *ſal ammoniac*, loaded with a great deal of acid, and involved by a great deal of ſulphur and earth. It is aperitive, diuretic, lenifying, and febrifugous. *Dioſcorides* gave the powder of its flowers in intermitting fevers. *Riverius* did the ſame, and it is ſtill the common febrifuge of the *Scotch* and *Iriſh*.

Chamæmelum fœtidum, ſtinking may-weed. This plant is acrid and bitter: it ſmells like *bitumen*, and gives a very deep tincture of red to the blue paper; which ſeems to ſhew, that it contains a great deal more fœtid oil than the preceeding. 'Tis uſed at *Paris* to aſſwage the pain of the piles.

Chamæpitys vulgaris, ground-pine. It is bitter, aromatic, and gives a faint red colour to the blue paper; by which it ſeems to contain ſome aromatic, oily, volatile ſalt, loaded with a great deal of ſulphur and earth, for by *analyſis* it yields ſeveral acid liquors, a little urinary ſpirit, a great deal of oil, and more earth. It is diuretic, emmenagogic, good in nervous affections, and diſſipates the cauſe of the gout.

[*To be continued.*]

ARTICLE

ARTICLE LIX.

LITERARY NEWS.

HOLLAND.

THE hiſtory of the conqueſt of *Florida*: or, A relation of what paſt in the diſcovery of that country. By *Ferdinand de Soto*; compoſed in *Spaniſh* by *l'Inca Garciliaſſo de la Vega*, and tranſlated into *French* by Sieur *Peter Richelet*. In *Octavo*, 2 *Tomes*; conſiſting of 558 pages, beſides the table and chapters, which contain 48. Publiſh'd at *Leyden*, by *Peter Vander Aa*. 1736. This hiſtory is an excellent one. The original author and the tranſlator have made a great figure in the republic of letters; the ſtyle is pure and flowing; an ingenious ſimplicity gives them an air of truth, which is one of the moſt eſſential qualities in works of this nature. Details, ſo exact and ſo circumſtantial, make us ſenſible that the author has wrote upon good memorials; and that he has not endeavoured to embelliſh any facts which he relates. He gives us a true picture of the manners of the *Indians*; of the character of their genius; of their policy; of their politics, and of the great attach they have for liberty. The *Spaniards* alſo make a great figure by their patience and valour; but all is diſfigur'd by their avarice and their diviſions.

ENGLAND.

There have appear'd of late in this country, ſuch crouds of pamphlets and books upon religion, that the titles alone will give us to underſtand whether they are proper to unite or divide the church moſt; ſome of which are as follows.

An examen of the ſyſtem of eccleſiaſtical power.

An anſwer to this pamplet.

The independent whig: or, A defence of the chriſtianity of the former Chriſtians, *&c.*

Thoughts upon religion, natural and reveal'd, *&c.*

A letter to a biſhop, concerning ſome important diſcoveries in philoſophy and divinity; beſides many others.

Would there be any damage, if without having any recourſe to the inquiſition or perſecution, a method ſhould be found to put a ſtop to theſe ſort of books which impoſe upon weak ſpirits, and ſerve only to multiply doubts, and to increaſe incertitude. There ſurely is ſuch a method to be found out, without offering any violence to the ſpirit and liberty of mankind; of which we ſhall at preſent ſay nothing, but when the method is entirely remov'd out of ſight, we ſhall then find the neceſſity of it, and be oblig'd to ſubmit to it.

ERRATA *in* September 1736.

PAGE 331. col. 2. line 45. read *unattended*. P. 332. c. 2. l. 10. for *afually* r. *caſually*.

THE